

SDM Virtualness Project

NASA Case Study

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MIT System Design and Management Program (SDM)

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Background

In the summer of 2001, NASA and Ford Motor Company co-sponsored a research project aimed at improving the education process and application of lessons learned through distant education. The System Design & Management Program (SDM) was used as a laboratory for improving distance learning capabilities. The research project was a follow up to previous research on globally dispersed teams. As the statement of work for the SDM Virtualness Project noted:

Distance students experience many of the local-global tensions felt by members of globally dispersed team members who must balance local priorities with time spent preparing for and participating in team meetings. Real-time, part-time distance learning students are often expected to be in class at times that conflict with critical meetings associated with their current work activities. During the virtual class, many students tend to multitask (read e-mail or continue to work on daily tasks while listening in) or are interrupted by people walking into their work area. The result is less than concentrated "mind share" on the learning process. Creating an environment where distance students are a virtual arm of the student body goes beyond the time they are "in" class and preparing for class. In some sense, it is a frame of mind as well as cooperation from all the people they need to work with.

Since distance tends to amplify any lack of alignment between stakeholders, it is important to assure alignment between local site and global objectives and priorities. In the case of distance learning, this means a need for clarity of expectations between faculty, program administration, partner organization sponsors, the student, and the student's immediate supervisor, peers and family. Clear expectations in the following areas form an environment for distance learning students to focus on remote interactions both in synchronous and asynchronous modes:

- organizational objectives for being in the educational partnership, i.e., what the organization expects of the distance learning student around

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- knowledge acquisition and diffusion and role as a change agent in applying newly acquired knowledge
- expected program demands placed on student and how those demands will be balanced between school, work and family
- impact of participation and completion of distance learning program on student's post-program job assignment and longer term career objectives
- impact on short term and long term organizational business results.

Longitudinal surveys of SDM participants support the above conclusions. Responses by members of the SDM Classes of '00 and '01 in four consecutive student surveys indicated that NASA's SDM/APPL program was potentially a best practice case concerning organizational support of career compatible, mid-career advanced education. [See attachment for survey highlights.] As a result, we conducted an in-depth case study of SDM/APPL at NASA to better understand the formation of NASA's career development program, how NASA selected and nurtured candidates, and the impact of SDM/APPL on NASA and the program participants. Using a framework developed in a forthcoming book,² sixteen interviews were conducted with NASA and MIT staff and program participants.

History of SDM/APPL

In 1999 NASA began to recognize that they were "going to lose upwards of 60% of their senior leadership over the next 10 years," according to one interviewee. In addition to the sheer number of people nearing retirement age, NASA had suffered from lower recruitment and retention problems over the previous decade. This led to a decline in the mentoring concept at NASA and impacted the organization's ability to retain knowledge and leadership.

In order to create a cadre of seasoned mid-level managers who could step into the perceived void, Dan Goldin, NASA Administrator from April 1, 1992 - November 17, 2001 realized that there was a need to create the Project Management Development Process Accelerating Leadership Option or PMDP-ALO. In particular, the goal of the program was to prepare "our best and brightest candidates for leadership of NASA's technical programs/projects." The program was developed under the aegis of the NASA Academy of Program/Project Leadership or APPL.

At roughly the same time a core group of MIT faculty began discussions about the need to work with organizations in the development and education of systems engineering principles. To address the market need for advanced systems engineering, the System Design and Management (SDM) program was created. This program develops core skills in system architecture, product development, systems engineering, project management, marketing, and organizational leadership. In addition to an intense curriculum, the

² J. Klein, *True Change: How Outsiders on the Inside Make Things Happen in Organizations*, Jossey-Bass Publishers, 2004.

program was also designed to allow students to participate at a distance so that they could continue to work while they obtained their degree. Students earn a joint Master of Science degree in Engineering and Management from the Sloan School of Management and the MIT School of Engineering. By drawing from both schools' curriculum, SDM students gain expertise in boundary areas and system integration issues. NASA saw a synergy between the SDM Program and the goals of PMDP-ALO and SDM became an integral part of PMDP-ALO. So much so, that many of the interviewees interchanged ALO and SDM in responding to our questions.

PMDP-ALO was billed as a program for the future leaders of NASA's programs and projects. Each center was directed to nominate the strongest two candidates from within their own applicant pool. As a NASA APPL presentation introducing PMDP-ALO to the entire enterprise stated:

MIT will only accept the absolute best candidates; MIT placement in the Systems Design and Management Program is extremely competitive, and placement is not guaranteed; MIT regularly denies admission to fully-qualified applicants due to the competitive nature of the program and the small class size; NASA will only forward the BEST.

The top down push for the PMDP-ALO program allowed the program to succeed in competition with other career development programs at NASA, especially since it did not conform to the typical application schedule for NASA career development programs. For example the NASA Fellows program which sends NASA engineers to business schools around the country operates on a typical MBA program schedule for application deadlines. PMDP-ALO required applications approximately a year and a half in advance of actual enrollment, requiring a large commitment not only from the prospective students but their managers as well.

ALO was structured as a three-year program, with two years allocated for the System Design and Management program at MIT but the understanding that applicants would be working and going to school. In general, candidates would spend only one semester on MIT's campus, completing the remaining five semesters of course work and thesis at a distance. Distance courses were delivered synchronously or asynchronously via video conferences or video compact disc. Each center would develop facilities on-site that could support the MIT technology. Finally, applicants needed to complete development assignments [described below] that could last up to one year.

Expectations

Because this was obviously disruptive to the projects and centers that the students came from, NASA announcements cautioned: "Managers and applicants must coordinate requirements and schedules so that no misunderstandings occur; don't fool yourself, this will be an extremely difficult challenge".

With the ALO program slated to draw participants from every center, NASA also needed to develop a reentry plan for the returning graduates once they completed their development assignment. In a government agency, this is no mean feat, since job openings are meant to be competitive. In order to attract the best candidates, NASA felt compelled to offer a way back into the work stream that offered minimal 'career' loss. HQ-99-106, a memo regarding PMDP-ALO reentry offered: "After successful completion of activities in the PMDP-ALO, the competitive service participants will be certified for noncompetitive placement in Level 3 and 4 program/project management positions for which the graduate meets the technical qualifications." Although not a primary deciding factor for the incoming ALO students, this proved to be an enticing benefit, especially at an organization where knowledge and learning are so highly prized. The opportunity to attend MIT while maintaining and possibly enhancing careers proved to be very attractive. As an ALO alumni said: "This was a chance to re-acquaint myself with current research, plus MIT is just a neat place to go"

Selection process

The NASA veterans selected for the ALO program had an average of 17 years NASA experience, ranging from 13-25 years directly with NASA. The majority had actually worked with NASA before that point under the aegis of other organization such as JPL, Boeing, and Lockheed Martin.

While they shared a strong commitment to NASA ideals and many years of experience, the initial PMDP-ALO classes were very diverse in their backgrounds and stated reasons for pursuing the program. Many were actively recruited by their center management. This reflects the impact of the top down push for the program had at each center. In addition to the simple desires for more knowledge and career advancement, the reasons for pursuing ALO fell into the categories in Table 1 with a fair amount of overlap.

Table 1: Reason for Applying to PMDP-ALO

Career transition
Career opportunity
Learning
MIT brand
Management encouragement

While PMDP-ALO compares favorably with other corporate support of distance education programs analyzed in this study, internally the feeling is that NASA struggles with career development issues like any large organization. As one person noted, "NASA doesn't do succession planning well, choosing the right people, for the right program, at the right time, SDM was a rare success." This success seems to come from the priority placed on sending the best candidates to MIT from management. It was emphasized that senior managers and center directors were encouraged to get very involved with the selection process for the two individuals that would be nominated by

their center. NASA was clearly "...looking for proven leaders at the mid-management level," commented one interviewee. This early emphasis resulted in top candidates being selected from the each center's applicant pool and the final ALO applicant pool being very strong.

Although it is not a validated way to assess 'desire', the NASA application process was daunting enough to sideline those people who would only pursue education to further their own interests. The people who applied were thus people who had the experience working within NASA, had clearly seen the good and bad, and were committed to helping NASA achieve its goals by working with the system.

Because of the organizational culture at NASA, the combination of comprehensive applications, rigorous screening, the chance to study at MIT, and the possibility of long-term career advancement resulted in a group of people who not only loved learning for the sake of learning, but loved to work at and for NASA.

Creating the cohort

Part of the SDM experience is an intense, group oriented, problem solving atmosphere. As an ALO alum put it: "...people in SDM were off the scale, I enjoyed watching the great leaders in my class work together". In addition to this emphasis on peer education the ALO program required the NASA cohort to have monthly teleconferences in which they practiced new skills and shared their thoughts on the educational process. The students found this so useful that they have continued this practice as alumni, using the time to keep up with intra-center developments and maintaining their extended networks.

Working together from a distance provided them experience working in difficult environments and across distance and time barriers. The stress of the experience helped to bond the cohort and the small teams they worked in. This positive reinforcement aided the learning process and made it easier for each ALO to absorb the SDM program and begin to apply it back to NASA. Finally, meeting colleagues who shared a common organizational background allowed them to strengthen their conviction in their ideas, individually and communally. One SDM noted, "I realized that I wasn't crazy, that other people at NASA felt similarly".

Another benefit of the ALO program for the students was and is their confidence in their virtual communication skills. The cohort realized that as a distance group, and a dispersed distance group at that, they were disadvantaged in comparison to their peers that were co-located or full time on-campus. To rectify this they developed their own micro network of networks, by connecting over email, instant messenger, and monthly teleconferences. This allowed them to work on school work together, bond as a cohort, and even troubleshoot work problems together. An alumnus reflects: "My communication skills with people at a distance and strangers have improved, my thoughts are better organized and I'm better at getting information out."

Development assignments

The ALO program's development activities were designed to emphasize "hands-on technical experience at a program/project deputy level." While many of the assignments were at a center other than their home base, some were at their home center or in private industry. The hope was that ALO participants would have a chance during the development assignment to not only spread their knowledge, but develop ways to work that knowledge into existing NASA operations. The assignments were planned to strengthen the systems concepts that the ALO's were exposed to in the SDM curriculum and provide a safe environment – and, one that demanded integrated social and technical skills – to practice what they had learned at MIT within NASA. Lastly, the assignments provided time to plan for re-entry into the work force.

Interaction between the ALO students and their center management led to many positive development assignments, such as, at contracting companies in fields where the center needed new skills to allow them to better coordinate with the contractor. These development assignments were a positive boon for the student, center, and presumably the development site. As one SDM noted concerning his development assignment, "...due to my thesis research I was able to match what was right for NASA with the correct way to do it. We picked a different analysis method and ended up saving money for NASA. I chose the approach due to my larger experience and knowledge pool and saved time and money for several hundred people."

In a few cases, however, the development assignments were unrelated to the ALO core goals or even done before the educational phase of the ALO program was complete. Although there were logistical and/or budgetary reasons for many of these decisions, there were feelings of regret and loss on the part of some students. Ironically, although the students sometimes missed out on the complete ALO experience, it sometimes led to students "being in the right place, at the right time" for career advancement opportunities that they otherwise would have missed out on. Unfortunately, in some rare cases, development assignments were never completed, although this again created some instances of career advancement by "good timing." Looking back, better coordination between the development assignment and the educational phase could have further enhanced the learning process. This would have also allowed wider networking for the alums and the overall NASA community, hopefully leading to broader knowledge diffusion.

The development assignments provided credibility to alums reentering the workforce. Because NASA is a large organization of highly educated people, "Going to MIT really means very little," one person noted. "If you really learn something, it will show up in your work." As a consequence, selling themselves and a vision for the future have become critical skills for all the ALO alums. They do not have instant credibility within NASA – if anything, they have had to prove that they are not just management's pets. They recognize that they have to go forth and produce high quality work. For a personal perspective, the benefit has been that they were able to keep their inter-center networks

because they were working as well as going to school. Their credibility doesn't stem from the ALO program, but rather from their long standing service to NASA.

Re-entry

NASA has very clear guidelines that govern their hiring practices – being within the public, there is the inability to 'guarantee' or otherwise secure jobs for the ALO's in advance of their program completion. That being said, in some cases, re-entry to the workforce has been coordinated by strong center leadership, even to the point where the returning ALO moves onto another center or role because of guidance from the center director or mentor. The benefit to NASA in these cases has been a very motivated ALO core that brings new ideas and excitement to their workplace every day. Because the jobs aren't on a "silver platter", the ALO's are not complacent or shy about pursuing jobs that interest them.

But like many organizations, NASA has experienced an administrative flux where center and headquarters leadership changed. Because the ALO program draws students from every center, some students found that their entire management chain changed during the time they are in the program. This created some consternation when it became time for re-entry back into their center. A small minority found themselves returning to their old positions and a feeling that they could not optimize the value of their learning. Although the individuals can bring new ideas and processes to their old roles, without a management structure to protect and nurture them, there can be a potential to shelve newfound perspectives and return to the status quo.

Recognition

NASA has done and continues to recognize and appreciate the ALO graduates. A graduation ceremony was held at NASA Headquarters and each graduate received a framed diploma. Interview comments indicated that this meant a lot to the alums. At an organization the size and complexity of NASA it is often difficult to recognize people, but when they are appreciated, it sinks in and has a long lasting positive impact on morale. This, in turn, makes the ALO's more willing to go the extra mile for NASA and motivates continuing effort.

In most cases, the NASA SDM contingent has gone on to larger roles within NASA. This has not been due to special effort or treatment on NASA's part, but rather due to their skill in networking and seeking out the right opportunities. Most feel that participation in PMDP-ALO was at least a factor in their advancement – potentially not as great a factor as they might wish, but still a decided advantage on their resumes.

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Unexpected development outcome: “Outsider on the Inside”³

Although SDM is billed as a program to learn systems engineering tools and concepts, most graduates leave with a much broader perspective of organizations, in general. This “outsider perspective” is an unintended consequence. An outsider’s perspective is an invaluable addition to leaders within an organization because they are able to overcome from some of their cultural biases and look at problems and opportunities differently. This is especially true for merit and knowledge oriented organizations, like NASA, where the culture tends to reinforce itself and lead to group think. Although the initial motivation for the ALO program was the relatively simple task of creating a cadre of mid-level leaders, all of the ALO participants underwent changes that they feel will benefit themselves and NASA. As a result, they became “outsiders on the inside” of NASA. They now wear “two hats”: as an insider and as an outsider who can apply an external lens to the workplace. ALO alums perceive this to be a value for NASA; they feel that they are better able to step outside of the NASA box than they had been in the past. As one noted, “Prior to MIT, I wouldn’t have tied that logic together, or been able to see the connections in the systems.”

The alumni group commented that the program offered a new way to look at and participate in their own organization. In many respects, this ‘outsider’ perspective was applicable not only to their career but to their personal lives as well. As one SDM alum noted, “...the program was life changing for me, improved the entire way I operate.” Another ALO commenting on his experiences post graduation stated that the SDM program “...reinforces personal patience and persistence. I see things from both the NASA and non-NASA perspective...we are people trained in how to do new things...”

Personal transformation is especially hard to quantify, especially when it occurs recently as noted by one alumnus: “...the big AHA came after I graduated and returned to NASA. I recognize the need at NASA, although I’m probably just now coming to grips with the entirety.” Another noted, “The hardest part is giving specific examples. My approach to problem solving, way of thinking, and knowledge depth are all changed and improved. How do you put a value on that?”

The challenge is to keep the outsider perspective whilst inside the NASA bureaucracy. Because the re-entry of most of the alums is still quite recent, it’s hard to gauge how likely they are to maintain their outsider perspective. As a unit they are exceptionally cohesive, not a single one has left NASA, and they are all excited about the chance to take their ideas forward and continue to help NASA live up to its mission statement. As much as the ALO alums realize they are different then they were when they entered, they have been tempered by their experience at NASA and the difficulty of being a change agent. The mottos are: “You don’t get help in NASA, you do it yourself or it doesn’t happen.” and “You can’t flaunt your education, especially at NASA.” In order to succeed, the ALO’s have maintained their cohort bond, keeping up their monthly teleconferences, relying on each other as resources and simply as a likeminded group

³ See Chapter 5 of J. Klein, *True Change: How Outsiders on the Inside Make Things Happen in Organizations*, Jossey-Bass Publishers, 2004.

with which to vent. Gaining perspective seems to be a function of time as well as exposure, although there were key elements in common for many of the ALO's much of the benefit was transmitted by the gestalt of the experience. The working hypothesis being that the outsider perspective is created by exposing insiders to new ideas, creating an environment in which they can then test these ideas out, and allowing them time to absorb the entire experience.

Applying their two hats

As NASA veterans, the alumni possess insider know how. In addition, they now have a new set of skills and a wider network with which to approach problems. In one case, SDM coursework translated directly to a NASA benefit when "...our analysis led to a paper that got distributed to the tiger team working on the problem."

Many of the ALO alums keep their course materials close at hand and certainly in their minds at NASA "...I carry the system architecture book around with me..." This affords them the chance to review or prepare for challenging events and reinforces their new skills. In particular students add value for NASA and enjoy "...using the three lenses [presented in the Organizational Processes course] to devise strategies accomplish my goals. Dealing with budget requests and understanding project delays, basically having the system principles in the back of your head when the project has a hitch," as one noted. Another student added: "I've used techniques from Technology Strategy to develop relationship matrices for technology selection. Identify the key parameters to track and see where the technology falls."

The ALO students continue to combine their new perspective and insider know how at NASA. By understanding the organizational culture, its needs, and high leverage points they hope to become successful change agents. Systems thinking is critical at NASA, but the feeling is that it's often not widespread enough, in many cases the ALO alums have been able to contribute because their knowledge pool and network are simply larger and deeper. As one person noted, "NASA is an organization driven by system interactions. Sorting out the components and parts and framing them in the system of systems view is very important. Practicing is very important; the importance of SE was the practicing of those architecture concepts."

Management support

Given the challenges of operating as a change agent within a large organization, one of the key elements that allow seasoned insiders to adopt an outsider's perspective is management support. The top down push that helped kick start ALO resulted in a reasonable amount of support for the ALO participants across the board. In many cases, the direct supervisors and center directors were the main impetus for people to apply. As the ALO's began to return to the workforce, this became increasingly important.

In many ways, the student needs a protected atmosphere in which they can practice their new abilities, typically to the advantage of the organization and themselves.

In many cases, the development assignments provided this outlet, a protected environment where the ALO's could assert themselves back into the workforce and integrate their new skills and perspective with the NASA culture. In other situations, strong center leadership provided an environment in which the ALO's could return to their old center and find new positions that would better take advantage of them.

"When you come back to NASA after being gone, they mushroom you for 6 months to a year...NASA doesn't want to push new people too quickly, they want to avoid anarchy."

Although this can be frustrating for the ALO's reentering the workplace, many have found that it helped crystallize their experiences. They see the connections between their new abilities and NASA's needs. This time apart also allowed them to develop strategies for their own success within NASA. As might be expected, a minority of the ALO population seem somewhat worn down by the process. Although they feel they are contributing at a high level, they are not seeing the adoption of ALO concepts within their immediate workspace and this has, at times, sapped their morale. Time will tell if they continue to wear two hats or if they find it more beneficial for their career and spirit to go back to the way they were.

Lessons learned

NASA started the ALO program to fill a perceived void in their leadership supply chain. At its inception neither the people designing the program, or those entering the program could have anticipated the transformational impact that ALO would have on them. This unexpected benefit of the program has provided NASA not only with a new crop of managers ready to take the reins over the next decade, but with an invaluable outsider perspective that has and continues to shape and improve NASA efforts.

The care with which NASA screened and selected applicants is a testament to the organizational culture and work ethic that pervades NASA. By only accepting the most driven and dedicated NASA got exceptional results from their Advanced Leadership Option. It also made it easier for the ALO's themselves to learn and grow in the program because they were surrounded by gifted and like minded classmates.

Combining distance learning, on campus participation, and scaled work place interaction helped to create the "outsider on the inside" perspective. Working, experiencing the stress and difficulties of collaborating at a distance, and being exposed to different perspectives and industries all led to an individual transformation for all of the alums. The bonding among the ALO cohort was an additional unintended consequence of the program. This bond continues to this day and serves to strengthen and renew their outsider perspective. Access to the increased network and knowledge pool will pay dividends for years to come.

ALO program coordination needs to continue as a priority if the program is to succeed. This includes planning for future classes and ensuring continued enrollment in the option. Advertising is of utmost importance, especially as NASA runs many career development programs. With ALO on a different schedule than most, it can be very difficult for managers and potential applicants to plan for something up to a year and a half in the future.

NASA needs a self replicating cadre of “outsiders on the insider”, not only to resolve their leadership crises but to provide broader solutions to NASA specific problems. To do this requires the active participation of the alumni as well as top down support. The alums must continue to apply their ideas and demonstrate the benefits of the ALO program to their peers, managers, and direct reports. Creating a sense of excitement about the program within the organization will make it easier for future generations to get sponsored for the ALO program.

Upper management resolve and support are especially important at NASA. Marketing and advertising are a crucial part of this support. Because the application deadlines are skewed compared to most fellowship or MBA programs, advance notice should be provided so that applicants are fully aware of their options. The graduation ceremony that was held for the ALO's is a good first step in recognizing their value and spreading the word within the organization.

Development assignments are still being completed, as is reentry for most of the alums. Because the long term impact have yet to be seen, a definitive solution to these problems remains to be found. On the whole, NASA is still the ‘best practices’ case, but there is always room for further improvements.

SDM Survey Responses -- January 2003

[Scale: 1=strongly disagree, 5=strongly agree]

	NASA			Other Sponsored SDMs			
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Sig. (2-tailed)
I report to the top management at my site about the SDM program on a regular basis.	6	4.00	0.000	25	2.44	1.325	0.008
I feel comfortable talking to my co-workers about the SDM program.	6	4.67	0.516	25	3.64	0.907	0.013
My organization is fully committed to supporting me through the completion of my SDM coursework.	6	5.00	0.000	24	4.17	0.816	0.020
Being in the SDM program has a negative impact on my performance evaluation on my job.	6	1.83	0.983	23	3.04	1.107	0.022
My organization provides excellent support (e.g., training staff, help desks) for using communication technologies.	6	4.33	0.516	23	3.22	1.085	0.022
I feel comfortable talking to my local supervisor about the SDM program.	6	4.50	0.837	25	3.56	0.961	0.036
The skills I acquire in the SDM program will be effectively utilized by my organization.	6	4.17	0.753	25	3.08	1.152	0.037
Organization leadership does not understand the major concerns facing employees in the SDM program.	6	2.17	0.753	24	3.21	1.103	0.038
My organization does not understand how to support employees when they are in the SDM program.	6	1.83	0.753	25	2.88	1.130	0.041